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Reducing Graphene-Metal Contact Resistance via Laser Nano-welding

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MOTIVATION AND CHALLENGES

- Flexible electronics
- Transparent electrodes
- Optoelectronics

- The large graphene-metal contact resistance is a major limitation for development of graphene electronics.
- Graphene behaves as an insulator for out-of-plane carrier transport to metallic contacts.

PROPOSED SOLUTION

Laser nano-welding of graphene to the metal contacts

- Laser-induced formation of defects.
- Increase the chemical reactivity of graphene.
- Avoid unwanted damage to channel region.
- Realization of a strong G-M bonding at laser-induced defects.

METHODS

I. Fabrication of the four-point probe structures

II. Laser nano-welding of graphene

A. Laser irradiation

B. Thermal annealing

RESULTS AND DISCUSSION

I. Reducing the Contact resistance via laser nano-welding

- Slight increase in R_c for all samples after the laser-irradiation.
- Significant reduction of R_c values after the annealing.
- R_c values as low as 2.57 Ω·μm obtained via laser nano-welding method.

II. Structural characterization using I_D/I_G Raman mapping

- A rise in the I_D/I_G ratio was observed only at the edges of graphene, where laser irradiation was performed.
- No change was observed at the channel region and the middle of graphene-metal interface.
- Performance degradation was avoided, due to selective mechanism of the laser-irradiation.

III. Carrier mobility

- Slight reduction in the mobility after the laser irradiation.
- Increased mobility after the thermal annealing.
- Improved carrier injection efficiency, due to the bonding formation at the edges of graphene.

CONCLUSIONS

- Laser nano-welding was developed and led to R_c reductions of up to 84%.
- Localized laser irradiation at the edges of graphene led to the formation of chemically active point defects.
- Precise structural modifications and formation of G-M bonding led to improved carrier efficiency in graphene devices.

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